The Impact of Direct Democracy on Public Education: Evidence for Swiss Students in Reading, Mathematics and Natural Science

Justina A.V. Fischer*
Stockholm School of Economics

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Abstract

Empirical analyses for the US suggest that stronger people's control over the school budget is deleterious to student performance. Using Swiss data on ninth graders in mathematics, reading and natural science collected jointly with the PISA study 2000, this paper tests this hypothesis for Switzerland, exploiting inter-cantonal variation in political institutions. For both student performance in reading and mathematics, stronger popular rights appear to lower educational achievement through the school budget channel. In particular, the qualification of teachers is identified as most influential determinant of student achievement, which is shown to be linked to educational spending.

Keywords: Direct democracy, public finance, economics of education, PISA

JEL Codes: H41, I28, H10

*Dr. Justina A.V. Fischer, Stockholm School of Economics, Sveavägen 65, SE-11383 Stockholm, Sweden. E-mail: justina.fischer@hhs.se

1 Introduction

Giving the people control over school budgets is conjectured to lead to lower educational spending and thus to lower academic achievement. In this paper, this assumption is examined for the case of Switzerland, a country with strong variation in the degree of direct democracy at the cantonal level. To test the claim of a negative impact, the analysis focuses specifically on the impact of direct democracy on educational budgets and its effects on student achievement in the core subjects reading, mathematics and natural science.

The unexpectedly mediocre performance of Swiss students in the 2000 international PISA study has rekindled discussion about improving the Swiss educational system.[1] The ongoing debates about school reforms are complicated by the fact that Swiss voters have an important influence on fiscal and budgetary issues through direct legislation. In general, direct legislative institutions restrict the financial means available to the government for the provision of public goods such as schooling (Bradbury, Mayer, & Case, 2001; Schaltegger, 2001; Fischer, 2005a).

Hence, this paper addresses the question whether citizens' control over the school budget necessarily leads to a lower quality of public schooling or not. In this regard, it contributes to the discussion in the United States on the impact of tax limits and tax caps on educational expenditures and student performance at public schools. While for the US a large number of studies are available, corroborating analyses for other countries rarely exist. Since Swiss cantons are heterogeneous with respect to the degree of citizen empowerment through institutions of direct democracy, and quite autonomous in their policies on public education, Switzerland seems especially suitable for such an analysis. Therefore, this study also aims at contributing to the discussion in the US by providing potentially supporting evidence from a country with a distinct cultural and historical background.

This article analyzes the impact of political institutions on the quality of public education using national individual data on Swiss ninth graders acquired simultaneously with data collection for the 2000 OECD-PISA study. Particularly, this paper explores the ways that direct democracy affects public schooling spending and student achievement in core subjects in Switzerland. In this regard, there are some related studies from the US exploiting differences in legal institutions across school districts and states. Their main finding is that the introduction of property tax limits or caps and thus, implicitly, a limitation of the school budget, leads to worse student performance in mathematics, natural science and reading.

In anticipation of the empirical results, direct democracy is first shown to considerably restrict the financial resources available for compulsory public education in Swiss cantons. Since the combined cantonal and local school expenses are the main source for public schooling in Switzerland, this limiting impact on the subfederal school budget can be considered crucial.

Subsequently, it is observed that if an educational production function is estimated, direct democracy leads to a considerable decline in student performance in reading and mathematics. In contrast, no such effect is detected for natural science. An important contribution of this paper is that the major (negative) impact of direct legislation seems to occur solely through the school budget and teacher qualification as a transmission channel. In the previous literature empirical findings on the decisiveness of financial resources and budget-related input factors tended to disagree (e.g. Hanushek, 2002).

On the other hand, the unmediated, direct impact of popular rights is insignificant for reading and natural science, while it is performance improving in mathematics. Thus, beyond its financial impact, no further additional detrimental effect of direct democracy on student performance can be observed. These findings may be viewed as supporting the hypothesis that, at least in Switzerland, no Leviathan-like administrators are present whose impact goes beyond the one captured by budgetary effects, contradicting results for the U.S.

The rest of the article is organized as follows. Section 2 provides a brief overview of the Swiss political and public educational system and develops testable hypotheses based on previous literature. Section 3 describes the data and model, and outlines the chosen estimation methods and the measure of direct democracy. Section 4 presents the estimation results for the institutional impact on educational spending and the PISA reading, mathematics and natural science test scores. Section 5 provides a cross-test subject comparison of the findings, while section 6 concludes.

2 Education Quality and Direct Democracy

2.1 *Direct Democracy*

In modern (semi)direct democracies, a representative democracy is complemented by direct democratic institutions. The most prominent cases are Switzerland and the United States, which are both also shaped by a very strong fiscal decentralization, with each level having its own sources of tax revenue. Therefore, there exists a direct institutional link between the power to tax and the power to spend, as direct legislative institutions provide citizens with the political means to influence both sides of the budget equally. In Switzerland, popular rights can be exerted at all three levels of the state (federal, cantonal, and communal). Cantonal constitutions differ with respect to the degree of direct democracy, which is exerted through initiatives and referenda. In addition, Switzerland is one of the most politically decentralized countries in the world, and the organization and execution of public education is among the core competencies of Swiss cantons (Germann, 2002; Lijphart, 1999: 38). The fundamental regulations of public education, school organization and the financial contributions of each state level are laid down in various cantonal laws on public education, which are subject to

voters' direct influence through statutory initiatives and referenda. In consequence, since all 26 cantons differ with respect to the degree of direct democracy in their constitutions, it is possible to analyze the impact of a change in citizen empowerment on the provision of public schooling (Feld & Kirchgässner, 2001).

Swiss cantons are not only responsible for the organization of (compulsory) public education but bear the financial burden for its provision (Swiss federal constitution, art. 62). Concerning the overall costs of compulsory education, the federal government contributes only 0.2%, whereas the cantons bear 38.8% and the communes 61.1%.[2] With respect to the communes, they mostly finance primary schools. In general, in all 26 Swiss cantons, two types of advanced education can be distinguished: basic education and education to meet advanced requirements (e.g. university preparation). Usually, the second type can only be entered on a selective basis, either through passing an entry examination or having obtained a certain average grade in the prior school year. However, as public education is in the authority of cantons, virtually 26 different school systems coexist within Switzerland, differing in their financial structure, organization and school curricula (Freitag & Bühlmann, 2003; Meunier, 2004). For example, in some cantons secondary I education commences after completion of the sixth year of schooling, while in others it starts after the forth or fifth year. However, in all cantons compulsory education, that includes primary and secondary I education, finishes with the ninth grade, excluding secondary II education. This distinction is important as the dataset which is employed in this study is based on student performance of ninth graders, at the end of compulsory education.

At the time of the study, there was a vast heterogeneity across cantons in the organization of teacher education.[3] Training of primary and secondary I teachers took place at over 150 cantonal teacher seminaries, and the regional validity of the earned teacher certificate impeded mobility of teaching personnel across Swiss cantons. In Switzerland, the duration of teacher training in these teacher seminaries varied regionally between one and four years. In

contrast, teachers for secondary II schools were educated at universities, where an at least four-year lasting study led to a subject-specific master's degree, e.g. a M.Sc. in Biology (supplemented by pedagogical courses). Whereas admission to university required a secondary II degree obtained after twelve to thirteen years of schooling, a primary or secondary I teacher *in spe* started her training after completion of compulsory education, namely after just nine years of schooling. Overall, the educational gap between these two types of teachers in Switzerland amounted to approximately four to five years of education. And even qualitatively, those who qualified for university studies had passed at least two selection processes during schooling, in contrast to those attending teacher seminaries (see EDK, 2001).

2.2 *The literature and hypotheses*

Institutions of direct legislation, argue their many supporters, serve as a means to discipline politicians and bureaucrats, who are assumed to behave in a Niskanen-like manner rather than as benevolent dictators (Niskanen, 1975). Specifically, these bureaucrats exercise monopoly power and aim at maximizing their budgets.[4] In consequence, means of direct legislation are thought to limit the government spending without negatively affecting the quality of the provided public goods, indicating an allocation of goods and resources closer to the median voter's preferences through reducing waste (Feld & Kirchgässner, 2001; Pommerehne, 1978, 1983; Besley and Coate, 2001).[5] In the US, people in favor of the introduction of school budget-restraining tax limits actually did believe that these budget cuts would lead to such efficiency gains in the provision of schooling (Temple, 1996). That, in principle, in economic reality such potential for improvement might exist can be concluded from the beneficial impact of competition among public schools, which lowered per pupil spending, but equally raised student test scores (Hoxby, 2000).

Local revenue and thus school budgets, in particular, appeared considerably reduced in the U.S. through the introduction of property tax limits, often through statutory initiatives (Card & Payne, 2002; Bradbury, Mayer, & Case; 2001; Shadbegian, 1999, 2003).[6] As regards direct democracy, for Switzerland various studies show that it leads to both smaller revenue and smaller expenditure of (combined) cantonal and communal budgets (Kirchgässner, 2002; Feld and Matsusaka, 2003; Hug, 2004). This effect is stronger for those policy areas in which Swiss cantons are granted political autonomy by the Swiss constitution (art. 3 of the Swiss federal constitution), specifically, the health system, culture, and education (Germann, 2002; Schaltegger, 2001).[7] In particular, in Switzerland government's educational expenses for several school types were found to be lowered by direct democracy (Fischer, 2005, 2005a). In contrast, Freitag & Bühlmann (2003) find no linkage between effectively used direct democratic institutions and educational expenses of Swiss cantons, while for the US Santerre (1989) identifies even an educational spending increasing influence in town-meeting type communities among 90 jurisdictions in Connecticut. On the other hand, Megdal (1983) reports ambiguous results for the effect of the existence of school budget referenda in 177 New Jersey school districts.[8] Some of these contradicting findings can, however, be explained by incomparability of institutions or level of analysis.[9]

In response to such budget constraints, in jurisdictions with stronger popular rights a reliance on user charges was observed that makes the quality of the public good more independent of the financial resources of the government (Feld & Matsusaka, 2000; Matsusaka, 1995). However, in the case of compulsory and free public schooling, this solution is (politically) not an option. Consequently, if the school administration were already working efficiently prior the decision to cut its budget, a decline in the quality of the public service should be revealed even though the school administrator in charge acted like a 'benevolent dictator'.

Modern economic theories of bureaucracies such as that of Niskanen, however, assume a selfish, namely budget-maximizing behavior of the administrator (e.g. Inman, 1979). Extending these theories, limitation of the budget is suggested to give rise to two different adaptive strategies. The first is a substitution of budget maximization with a re-allocation of means between budget components such that administrative staff is increased at the expense of the resources available for production of the public good (Williamson, 1964). The rationale for this strategy is that a large personal staff gives the bureaucrat a feeling of importance and power (Downs, 1967). Thus, when facing the decision to cut either administrative or instructional spending, a Leviathan-like school administrator is expected to choose the latter. Indeed, for U.S. school districts, Figlio (1998) shows that the above mentioned tax limits are associated with a spending shift from the teaching component to the administration component of school budgets (see also Dye & McGuire, 1997; Figlio, 1997).[10] Equally, such spending shift was then found to be mirrored by larger class sizes, higher pupil-teacher ratios, lower beginning teachers' wages, worse teacher qualification, unchanged level of school service, but, on the other hand, ongoing overstaffing of administrations (Downes, 1996; Figlio, 1998, 1997, 1997a; Shadbegian, 2000, 2003; Poterba & Rueben, 1995).

Alternatively, Figlio & O'Sullivan (2001) propose a manipulative bureaucratic behavior in which the administrator deliberately allows the quality of the public good to decline by allocating (relatively) fewer financial resources to its provision. Being persuaded that budget limitation has a deleterious impact on the quality of the public good, the administrator expects the electorate to overrule ('override') the previous tax limit vote in the next election. Indeed, Figlio & O'Sullivan (2001), using expense data for police, fire protection, and general administration from 5,150 U.S. cities, show that in those cities with a so-called 'override option', the deterioration in public service was larger than in cities without this option. Moreover, they observe the same phenomenon with respect to teacher-administrator ratios in school districts with an override option.[11]

In consequence, in both cases of adaptive behavior of the bureaucrat, budget cuts will lead to a decline of the quality of the produced public good. As regards the research question of this paper, the quality of public schooling might be assessed using objective measures of student achievement. For the U.S., during the 1990s various empirical multivariate analyses of the impact of newly introduced tax limits on student performance were carried out.[12] Most of these studies are based on a simple educational production function augmented with a tax limit dummy that replaces traditional school resources and input variables such as e.g. class size or teacher quality (e.g. Figlio, 1997). For example, in a cross-state analysis, Figlio (1997) reports a substantially lowering influence of tax limits on student performance in science, social studies, and reading examinations. Moreover, Downes and Figlio (1997) find a tax limit associated with a sizeable and significant decline in statewide mean student performance in mathematics (cf. also Downes, Dye, & McGuire, 1998).[13]

However, to my knowledge, non of the 'tax limit literature' tests the direct relation between educational spending and student performance, although all of them conjecture the school budget to work as tax limit's transmission channel.[14] Other educational economists, however, report ambiguous results with respect to the influence of spending or school resources on students' test scores (for reviews, see Hanushek 1986, 1996, 2002).

Based on this evidence, I formulate the following hypotheses which I intend to test with Swiss data:

Hypothesis 1:

Direct Democracy exerts a spending restraint impact on educational spending.

Hypothesis 2:

Direct democracy increases efficiency in the provision of schooling. Thus, through smaller school budgets direct democracy has no detrimental impact on student achievement.

Hypothesis 3:

Direct democracy does not lead to efficiency gains. In consequence, it leads to worse student performance caused by the induced school budget cuts.

Hypothesis 4:

Direct democracy provokes counteraction of Leviathan-like school administrators. Consequently, not only through smaller school budgets, but even more through activities of the bureaucrats going beyond the financial realm student performance is worsened.

3 Data and Model

3.1 *The Data*

Sociodemographic, economic and fiscal determinants at the cantonal level and a cultural (language) factor are obtained from the Swiss Federal Statistical Office; some aggregate indicators such as ideology of cantonal government, tax competition and fiscal constraints are based on my own calculations or that of my colleagues Lars P. Feld, G. Kirchgässner and Ch. Schaltegger. Cantonal culture is measured by a dichotomous variable for French- and Italian-speaking cantons. The expenditure variables are for combined local and cantonal educational

per pupil spending in primary and secondary I education.[15] All monetary variables are deflated to the base year 1980.

For estimating an educational production function composed of school characteristics, classroom-related characteristics, peer characteristics, and, student background information, the so-called national study accompanying the PISA 2000 survey is employed.[16] This national studies used identical questionnaires for the same test subjects, statistical methods of sample selection and test score construction as the OECD PISA 2000 survey. Due to its focus, more students were assessed in reading than in the two other subjects. However, in contrast to the OECD-PISA study, which sampled the 15-year old irrespective of their educational stage, the population of the national study includes only ninth graders. For this reason, the matching of schools and students makes it possible to construct classroom-based peer variables. As in the OECD PISA data, test scores are obtained as weighted likelihood estimates. More specifically, they are constructed as a weighted average of correct responses, with the weights reflecting the level of difficulty of the question (Hambleton & Swaminathan, 1985; Warm, 1989). In consequence, a student who answers one more challenging question correctly might perform as equally well as someone who gave correct responses to a small number of more simple questions.

Students attending classes of less than 20 are excluded from the analysis to prevent endogeneity in the peer group variables because in smaller classes the respondent's performance is more likely to have an impact on the average achievement of her peers than in larger classes.[17] The mean of the reading test score was originally normalized at 500, with a standard deviation of 90 for the whole national dataset, but because of the deletion process, the mean of the sample I use is about 530, with a standard deviation of approximately 80 based on a final sample of about 3,530 observations. For descriptive statistics of the core subject test scores, see Table 1.

Insert Table 1 about here

Finally, as explanatory variable of interest a measure of direct democracy is employed which was constructed for the year 2000 based on the methodology described in Stutzer (1999). It is an unweighted average of four subindices that evaluate the power of the constitutional initiative, the statutory initiative, the fiscal referendum, and the statutory referendum. The strength of these popular rights are assessed based on the stipulations in the cantonal constitutions with respect to the number of signatures to be collected, the number of days available for their collection, and the financial threshold of the expenditure project, if applicable. The four subindices are constructed based on the awarded points for each single requirement with a higher number reflecting stronger popular rights. As most of these subindices of direct democracy are highly correlated with up to $\rho = 0.8$, using the overall index in place of the single subindices is highly recommended. The overall index of direct democracy takes on values between 1 and 6, with 6 indicating the highest degree of empowerment of the cantonal electorate. In our data, the lowest value (1.75) is observed for the canton 'Geneva' while the highest is achieved by 'Glarus' (5.75). For the year 2000, the values for all 26 cantons are displayed in Table A1 of the Appendix.

Nevertheless, this index measures the presence of these institutions rather than their effective use. Feld & Kirchgässner (2001) demonstrate that the mere existence of such an institution is already sufficient to induce a change in policy outcomes because it serves as a credible threat by the citizenry in a game theoretical context. According to this model, popular rights are only actively exerted in case of strong deviations of the politicians' decisions from the median voter's preferred policy. In consequence, employing a measure of effective exertion of direct legislation would understate the true effect of this institution. In addition, it

should be noted that this approach follows most of the public finance and public choice literature. Definitions and descriptive statistics of all dependent and explanatory variables are provided in Tables A2 and A3 of the Appendix.

3.2 *The Model*

To test hypothesis 1, a typical model of public finance will be estimated. The following equation describes such an expenditure function:

expenditure = f(**democracy**, *economy, politics, sociodemographic factors, culture*).

In this model, government expenditure is regarded as a function of the degree of direct democracy. As controlling variables, also included are measures accounting for fiscal decentralization (defined as share of local expenses in total cantonal and local expenses), urbanization of the canton, cantonal wealth, size of canton, tax competition, a fiscally effective constitutional 'break', the share of young, old people (< 20 years, > 60 years, respectively) and educated people, government ideology (with positive values indicating a conservative position), coalition size, and cantonal culture, proxied by the dominating language. A prediction of the impact of these controls and their theoretical foundation can be found in Feld, Fischer, & Kirchgässner (2006).

Hypotheses 2 through 4 will be tested by estimating a reduced form and a structural form of an educational production function model. In contrast to the reduced form, the structural form also includes revenue-driven 'endogenous' input factors that serve as potential budgetary transmission channel of direct democracy. These endogenous input factors include teacher qualification, teacher shortages, total hours of schooling, student-teacher ratio, access to PCs,

availability and quality of instruction material, and state of school building or availability of space. Consequently, the structural form to be estimated looks as follows:

performance = f(***democracy****, culture, individual, peers, school, canton,* ***school inputs***),

where *democracy* denotes again direct democratic institutions, and *culture* the main regional culture of the school location. *Individual* denotes the student's individual and family characteristics such as gender and parents' education. *Peers* stands for peer group characteristics that aim at measuring the external effects of the peer group on an individual's academic performance.[18] *School* denotes non-revenue-driven school/class-related characteristics like the selectivity of the institution or problems with class discipline. *Canton* represents cantonal sociodemographics which serve as proxies for missing individual and peer group characteristics in class (e.g. religion, poverty). Finally, *school inputs* denote revenue-driven school inputs as described above. For predicting the impact of the sociodemographic and peer controls, see e.g. Winston & Zimmerman (2003) or Figlio (1997).

In the reduced form of the model, the 'endogenous' variables are excluded, so that the following equation results:

performance = f(***democracy****, culture, individual, peers, school, canton*).

Estimation of both the reduced and the structural form of the model allows then to test hypotheses 2 through 4, in particular, (1) whether school inputs affect student performance, (2) whether they serve as transmission channel of direct democracy, and (3) whether a non-budgetary influence of direct democracy prevails. Most of the US literature which identfies an institutional impact employs variations of the reduced form of the model, but not of the structural form. To my knowledge, only one estimation reported in Downes, Dye, & McGuire

(1998) resembles the structural model most.[19] In other words, most of the US literature does not directly test the presence of a transmission channel of the budget constraining institution.

3.3 *Methodology*

The expenditure regression is estimated with OLS using aggregate data that form a synthetic panel with 26 cantons as observational units per year between 1980 and 1998. Newey-West standard errors correct for heteroscedasticity and serial autocorrelation, and the Jarcque-Bera test assesses the presence of outliers. As robustness test, the identical model is estimated with those observations excluded with residuals above or below 1.5 standard deviation.

As regards the educational production function, both the reduced and the structural model are estimated using ordinary least squares (OLS). Standard errors of the coefficients are corrected for heteroscedasticity, but also clustered at the school level (Moulton, 1990). This latter correction takes into account that students who attend identical schools share common factors both at the school and cantonal level – for example, condition of the school building and political institutions in the canton.[20]

Besides the peer effects discussed above, some of the remaining determinants of student achievement, however, might be subject to potential simultaneity. For example, frequency of individual homework feedback or a higher age could be proxies for bad grades at school. Additionally, the selection of pupils into different school types (and classes) is not fully taken into account with this estimation method. Simultaneity might induce a bias in the estimated coefficients. An instrumentation of endogenous variables or a correction for sample selection, however, cannot be carried out because the PISA data do not provide the necessary exogenous instruments (for a discussion, see also Rangvid 2004, Graddy & Stevens 2005).

For space constraints, the discussion of the estimation results for educational spending and student performance focuses on the influence of the variables of interest, in particular the extent of direct democratic rights and the 'endogenous' budget-driven input factors.[21]

4 Estimation Results

4.1 *Direct Democracy and Educational Spending*

The first hypothesis is tested by analyzing the impact of direct democracy on combined local and cantonal per pupil spending for compulsory schooling in Switzerland. For this purpose, a model of government spending using a synthetic panel from 1980 to 1998 is estimated. The dependent variable has been logarithmized. In Table 2, the negative coefficient of the institutional variable indicates that direct democracy exerts a spending-lowering influence on primary and secondary I education, with significance at the 1 percent level. Thus, stronger citizen empowerment leads to less annual spending for compulsory education, ceteris paribus. An adjusted R2 of about 0.72 confirms the good explanatory power of the model. The normality of the distribution of the residuals is rejected (at the ten percent level), but an exclusion of outliers above or below the 1.5 standard deviation limit leads to identical empirical results with respect to the impact of direct democracy and for most of the remaining predictors. Splitting up the expenses by current and investment spending, which usually fluctuates more erratically over time, finds an identical restraining impact of stronger citizen empowerment for both budget components (see Table A4 of the Appendix). Clearly, these estimation outcomes are in line with previous empirical analyses and in strong support of hypothesis 1 which stated that less money would be spent on education in the presence of stronger popular rights.[22]

4.2 *Student Achievement in Reading*

The first two columns of Table 3 display the OLS estimation results for reading for both the reduced form and the structural form of the educational production function. In the reduced form, direct democracy exerts a performance lowering impact on an average student (significant at the 5 percent level). As regards the size of the impact, it appears to be considerable. Since this index ranges from 1 to 6, the maximum reduction in the test score for an average student due to direct legislative institutions is about 46 difficulty adjusted test score points, which is slightly more than half a standard deviation. Nevertheless, more sizeable impacts by far are exerted, for example, by high parental income, age, gender, the situation of the pupil at home, and the selectivity of the attended school (see Table A5 of the Appendix for complete results).

In the structural form that includes the educational input factors at the school and class level that are financed through cantonal and local sources, the OLS estimate of the index of direct democracy is equally negative, but it is far from being significant at any conventional level (column (2)). Clearly, for an average student, political institutions do not exert any significant impact on reading test scores if revenue-driven input factors are explicitly taken into account.

Regarding the school resource-driven input variables, no access to a PC at school appears to be detrimental for an average student's academic achievement in reading.[23] The shares of teachers who have obtained a master's degree at a university, on the other hand, are associated with a higher test score, exerting an impact of considerable magnitude. Nevertheless, the coefficients of the remaining input factors, such as conditions of the school building, lack of instructional material, shortage of teachers, hours of teaching and student-teacher ratio, are not significant at any conventional level. The adjusted R2 of around 0.27 for both regressions indicates a good fit of this model for a cross section.

In sum, a significant performance decreasing impact of direct democracy is observed in the reduced form and an insignificant coefficient in the structural form. Obviously, the disappearance of its significance in the structural form is due to the inclusion of these revenue-driven input factors. Consequently, school budget-related input factors appear to serve as transmission channel of direct democracy, particularly having access to PCs and teacher qualification. This view is supported by the fact that direct democracy was shown to dampen subfederal expenditure for public schools in the previous regression (Table 2) and thus potentially restrain spending for school budget-dependent inputs at the school and class level.

In the reduced form, the performance lowering influence clearly contradicts hypothesis 2 that no deleterious influence of lower educational spending would be present due to efficiency gains in the provision of public education. The estimation results of the structural form lend support to the budget-channel hypothesis 3, but equally partly reject the Leviathan-administrator hypothesis 4, as no further deleterious institutional impact beyond the one through the endogenous, budgetary variables is detected. Clearly, the estimation results suggest that fewer financial means available at the subfederal level for public schooling do translate into lower student performance. It can also be concluded that 'money matters' for student performance in reading, a noteworthy epiphenomenon of the empirical results.

4.3 *Student Achievement in Mathematics*

The OLS results for the reduced form in Table 3 column (3) reveal an insignificant impact of direct democracy for an average student in mathematics. In contrast, the OLS estimate in the structural form (column (4)), when endogenous input factors are taken into account, yields a significant performance enhancing effect on test scores (at the 5 percent level). The size of this estimate indicates that a jump from the lowest to the highest level of direct democracy

would translate into a sizeable effect of about 63 additional test score points, almost as large as the standard deviation of 80 points in mathematics.

As regards the revenue-driven input variables, influences similar to those obtained for reading are found. Most particularly, for the average student the share of mathematics teachers with a master's degree appears to have a significant and sizeable test score raising influence (at the 1 percent level), and the coefficient of the share of university educated persons in the teaching personnel is also positive and close to statistical significance. In addition, a higher number of hours of schooling is positively associated with student performance, although with a small-sized impact. However, none of the remaining input controls, including the equipment of schools with PCs, are of importance for the student achievement in mathematics.

Reflection on the findings for mathematics – particularly a comparison of the results for both forms of the model – leads to the conclusion that the insignificant coefficient of direct democracy in the reduced form must have been caused by the mutual cancellation of an observable positive (direct) influence and an assumedly negative mediated through the revenue-driven input factors. As the significance level of the coefficient of direct legislation changes through control of these endogenous inputs, which are most possibly also influenced by this institution, they obviously serve as transmission channels of this institution. Thus, the results reflect again a performance dampening indirect impact of direct democracy through lower educational spending, clearly contradicting the efficiency-gains hypothesis 2, and rather in line with the budget-channel hypothesis 3. A second conclusion might be that fewer financial means at the subfederal level do matter for student performance

However, we also find an achievement raising direct institutional impact in the structural form of the educational production function. This result suggests a rejection of the Leviathan-administrator hypothesis 4 as no further detrimental impact of direct democracy going beyond the school budget channel is detected. This performance improving finding might indicate

that in more direct democratic cantons teaching of mathematics is favored by the school administrations in a way that cannot be captured by the inclusion of our available school input factors.

Insert Table 3 about here

4.4 *Student Achievement in Natural Science*

As regards natural science, in the reduced form the OLS estimate of the coefficient of direct democracy on student test scores indicates that for the average student there is no significant effect of direct legislation on student performance (see Table 3 column (5)). Also in the structural form of the model, the coefficient of the variable of interest is insignificant (column (6)). This result can be interpreted to mean that taking into account the potential influence of direct democracy through the subfederal budgetary channel reveals no institutional impact beyond the indirect one.

Patterns of influence similar to those for reading and mathematics are observed for some endogenous input variables that form part of the structural form. As in reading and mathematics, the qualification of (natural science) teachers appears to be a very decisive predictor of student performance both in terms of significance and size (at the 5 and 1 percent levels of significance). Also, as in mathematics, more hours of schooling improves academic achievement, but still exerting an impact of negligible size. In contrast to reading and mathematics, however, a shortage of teachers also appears to be detrimental (at the 5 percent level), while student-teacher ratio only appears weakly significant (at the 10 percent level). Further, the lack of instructional material is strongly associated with lower test performance in

natural science (at the 1 percent level). As in mathematics but in contrast to reading, however, the equipment of the school with PCs is not an influential factor of test scores.

To summarize the findings for natural science, institutions of direct legislation do not appear to influence student performance in any way. A comparison of the findings for the reduced and structural forms reveals no achievement decreasing impact of direct democracy mediated through the school budget, clearly rejecting hypothesis 3. Because the number of observed students for natural science is similar to that of mathematics test-takers, it is unlikely that the insignificances are caused by a small sample size. Thus, it is concluded that stronger empowerment of the people has no effect whatsoever on student performance in natural science in the ninth grade.

4.5 *Robustness tests*

Estimation of the identical models with missing values replaced by imputed values using a hot deck imputation method did not lead to substantially different results to the ones presented above. Also, the findings for direct democracy were quite robust to small alterations in model specification, like the inclusion of cantonal per pupil school expenditure as additional endogenous determinant or the omission of peer variables.[24] Unfortunately, limited availability of data did not allow to replace the revenue-driven school inputs with institution-specific spending data. Moreover, the results appeared quite insensitive to the exclusion of single cantons from the sample.[25]

It might be argued that the magnitude of the teacher qualification coefficient is an indicator of model misspecification. Testing several non-linear specifications, however, teacher qualification remains the most important determinant in terms of significance level and size. A model misspecification and biased estimates, however, might still be present in case teacher qualification proxied the attractiveness of the school: schools with well-

performing and thus easy-to-teach students might be favored for employment by prospective teachers.[26] To address this problem, several other variables in the model aim to control for school attractiveness, such as measures of type and location of school, and, most important, average and heterogeneity in performance of the respondent's peers, that might proxy school-specific student body intelligence. Furthermore, the actual confidence intervals of the teacher qualification coefficients are wide, ranging roughly from 0 to 50, indicating that for the single school the magnitude of its actual effect varies considerably from being negligible to being decisive. This result supports the view that the bias of the teacher qualification coefficients is probably small.

Furthermore, inclusion of controls for particular school types, for example by their focus either on a professional or an academic career, or by their stage of education (primary vs. secondary I) would have been desirable, but could not be realized: In Switzerland, as described in the introductory paragraphs, each canton has its own school regulation and organization. In consequence, institutions of public education below the university level are often barely comparable so that an inter-cantonal variable for different school types could not be constructed. Furthermore, the number of students tested in a specific canton is often too small to allow for canton-specific school type indicators. Included is, however, a measure of 'selectivity' of the institution based on the school principal's information.[27]

This study employs data from the national study, which comprises two data sets: one that covers whole Switzerland (the 'Swiss' sample) and one that represents only the French-speaking regions (the 'French' sample). It might be argued that merging two datasets might bias the estimation outcomes due to potential overrepresentation of the French-speaking students. However, testing the models with the smaller Swiss subsample and application of transversal weights yields qualitatively identical results.

4.6 *Direct Democracy and Teacher Qualification*

Nevertheless, the chosen procedure and the estimation results might still not fully convince that direct democracy influences student performance through teacher qualification unless an analysis of the direct relations between political institutions, educational spending and teacher qualifications is carried out.

Figures 1 through 4 illustrate the correlations between the four different teacher qualification variables and the index of direct democracy averaged over 1990 to 2000. The decreasing regression line suggests that there exists a negative correlation between the extent of citizen empowerment and the share of teachers with a master's degree, particularly for the three tested subjects.[28]

Insert Figures 1, 2, 3, and 4 about here

In addition, a model of demand for high quality teachers based on around 150 schools has been estimated. The variable of interest is the log of subfederal educational spending for compulsory schooling per pupil averaged from 1990 to 2000 to capture long-term effects and mitigate endogeneity. If higher levels of educational spending were driven by higher teacher wages and a better equipment of schools that facilitate teaching, a higher share of university graduates would choose the teaching profession.[29] Following demand for school resource models presented by Figlio (1997, 1998), Poterba (1997), and Hoxby (2000), I also include controlling variables both at the cantonal and the school level that account for school and socio-demographic characteristics determining the need of and demand for higher qualified teachers, that are not (fully) captured by the educational spending variable.[30]

The estimation outcomes for the variable of interest, based on the samples with outliers excluded, are presented in Table 4.[31] They indicate that educational expenditures for compulsory education are positively associated with the proportion of teachers holding a master's degree in the three core subjects reading, mathematics and natural science, and in the overall teaching body. Replacing the spending variable with the direct democracy variable reveals an identical (negative) relation for the three core subjects only (not reported). Clearly, these findings correspond with figures 1 through 4 which depict the negative correlations between direct democracy and teacher qualification. [32]

However, since this analysis is based on cross-sectional data and with variation of institutions at the cantonal level only, these estimation results should be interpreted with some caution. On he other hand, having used averages of school expenditure data helps overcome a bias induced when employing contemporaneously measured school inputs. Furthermore, estimation at the more disaggregate school-level mitigates the distortion induced by measuring educational expenditure at the cantonal level (see Hanushek, 2002; Hanushek, Rivkin, & Taylor, 1996)

Insert Table 4 about here

Clearly, the estimation results suggest a strong linkage between educational spending or direct democracy and teacher qualification. In particular, in Swiss cantons lower educational spending levels seem to make the teaching profession less attractive to university educated persons. These unfavorable findings are quite in line with evidence presented by Figlio (1997, 1997a, 1998, 1999; Figlio & Rueben, 2001), who showed in school districts with a budget restraint (tax limit) not only teachers' starting wages to be lower, but also quality and

qualification of newly employed teachers to be deteriorated, most probably through the wage channel.

5 Comparison of the Results for Reading, Mathematics and Natural Science

The empirical results for reading, mathematics, and natural science reflect completely different findings and elicit interesting interpretations. These results are discussed with respect to the direct and indirect impact of direct democracy on overall student performance in a subject, and the allocation of given resources between subjects.

For both reading and mathematics, we find strong support for school budgets and teacher qualification working as a transmission channel of direct democracy. More precisely, the indirect, mediated effect of direct legislation appears to be test score lowering, and for both subjects, the lack of available financial means for public education at the subfederal level appears responsible. This estimation result contradicts empirical literature by education economists such as Hanushek (1986) and Hanushek, Rivkin, & Taylor (1996) who found no link between school resources and student performance.[33] On the other hand, my conclusions are supported by similar views expressed in more recent studies such as Graddy & Stevens (2003), Pan, Rudo, & Smith-Hansen (2003), or Pan et al. (2003). Such test score lowering institutional impact, however, is not made for natural science, possibly because, in contrast to mathematics and reading which are taught from the very beginning of compulsory schooling, physics and chemistry are introduced into the school curricula only in higher grades.[34]

In particular, qualification of the teaching personnel is identified as important determinant of student achievement in all three test subjects. Moreover, teacher qualification at the

university level appears positively linked to educational expenses and negatively to the degree of direct democracy, as expected. In addition, these results indicate that costly equipping schools with particularly human capital resources is important for student performance in these subjects, and is in contrast to the claims by some politicians and educational economists that teacher qualification did not matter for student performance.[35]

In this study for Swiss students, the significant impact of teacher qualification might well be country-specific as the gap between high and low qualified teachers is wider in Switzerland than in other countries like the US. In fact, Meunier (2004) finds teacher qualification equally decisive for Swiss student performance.[36] Specifically, as stated in section 2.1, at the time the study was conducted training of teachers in Switzerland meant either earning a master's degree at universities or graduation from so-called 'teacher seminaries' with a degree equivalent to completed secondary II education, thus far below the bachelor's level (EDK, 2001: 152).[37] In contrast, in other countries teachers are exclusively educated at universities and complete their training with either a bachelor's or a master's degree.[38] Consequently, while studies on the influence of teacher qualification in the US have yielded ambiguous results, the observed importance for Swiss students might rather be in line with previous research that detected a strong positive correlation between teacher IQ or test scores with student performance (see Hanushek, 2002, for a survey). The importance of teacher quality for educational achievement, should not be understated as a 'good' teacher appears often as most decisive factor of student achievement, with an influence far beyond that of e.g. class size (Hanushek, 1992). For example, a good teacher lets students gain additional increases in testable knowledge equivalent to up to one school year and might be able to bridge gaps in educational achievement caused by e.g. differing family background (Hanushek, 1992; Rivkin, Hanushek, & Kain, 2005).

However, regarding the direct, unmediated impact of direct democracy on student test scores in the structural form of the educational production function, the findings indicate a

performance enhancing effect for mathematics and an insignificant one for reading and natural science. This result contradicts the findings in Downes, Dye, & McGuire (1998), the only study in which endogenous input variables are controlled for. (All the remaining studies on tax limits and student performance cited in the paper tested only the reduced form). In particular, Downes, Dye, & McGuire (1998) report a deleterious effect of budget-reducing tax limits for *both* forms of the educational production function. Thus, for Switzerland, the hypothesis of a Leviathan-like behavior that goes *beyond* the one taken into account by the budgetary endogenous input factors (hypothesis 4) has to be clearly rejected, contrasting results for the US. However, as long as it is not tested whether all school budget components are equally reduced by direct democracy or not, a complete rejection of the Leviathan-hypothesis is not possible. Such analysis, however, goes beyond the scope of this paper.[39]

A conjecture about direct democracy inducing a reallocation between test subjects is possible if the results in the structural forms for reading, mathematics and natural science are compared. Based on such a comparison, it might be concluded that a reallocation of given means, particularly a shift of given resources to mathematics, could have occurred in more direct democratic cantons. However, given that the regression results reflect only a small portion of the school curriculum, it is unclear from which school subjects the additional resources for mathematics have been withdrawn. Based on median voter models (e.g. Feld & Kirchgässner, 2001), it can be conjectured that such re-allocation, induced by stronger institutions of direct democracy, again reflects the politicians' response to the electorate's preferences. For example, school administrations in more direct democratic cantons might respond to such demand in the population by putting a particular focus on quality checks of mathematics teaching. Such demand might arise from a greater awareness of the importance of financial issues and knowledge of mathematics as tool for their assessment that might be correlated with stronger popular rights, which includes deciding about government expenditure projects. Equally, based on Becker's human capital theory (Becker, 1964), such

preference might mirror relatively higher wages earned in 'male' professions that require strong mathematics skills, such as e.g. engineering or management positions. The demand for prioritizing mathematics skills might be correlated with citizen empowerment if gender-specific asymmetries in the distribution of political power are present.

6 Conclusion

For the U.S., Figlio (1997, 1998) shows that local tax limits that reduced the tax base for local school budgets lead to larger class sizes, lower teacher wages, and worse teacher quality, but not to any reduction in administrative personnel. These results suggest that instead of the expected efficiency gains in the provision of public schooling, cutting the school budget might have caused a decline in the quality of educational service. For the U.S., this decline in academic achievement is indeed corroborated by recent analyses of the impact of tax limits on student performances (e.g. Figlio & Rueben, 2001). Based on these results for the U.S., a test score decreasing impact of direct democracy on student achievement would not be a surprising result for Switzerland, as its political institutions can been shown to restrain subfederal expenses for schooling.

This study aims to provide such evidence for similar or dissimilar effects of direct legislation on public education in Switzerland, a three-tier federal country with an autonomous school policy-making at the state level. Using a cross section of individual data on student performance in Switzerland in three core subjects obtained from a national study accompanying the OECD-PISA 2000 study, an educational production function augmented by institutional determinants of direct democracy is estimated. This model specification is similar to those previously employed both in public finance studies and in analyses by

educational economists. For Switzerland, the degree of direct democracy is measured by a composite index that indicates the extent of overall empowerment of citizenry. In this study, as first step the spending restraint impact of direct democracy on educational spending is identified. Then, two major variations of the production function are estimated: first, a reduced form that excludes endogenous, budget-driven input factors at the school and class level, and second, a structural form that includes these factors. This variation in model specification makes it possible to distinguish the direct institutional impact from an indirect impact, and equally to determine whether school budgets serve as direct democracy's transmission channel.

For the reading literacy test, in the reduced form of the model, the findings from the OLS regressions indicate that a higher degree of direct democracy leads to lower performance by students in reading literacy test. This finding mirrors results obtained for the U.S. for the influence of tax limits. However, after the inclusion of variables controlling for various revenue-driven input factors at the school and class level, the negative influence of direct democracy disappears completely. From this result, it is concluded that school and class input factors whose quality is dependent on the school district's financial equipment are important for student academic achievement, and that the test score lowering impact of direct democracy occurs through the subfederal budget. Finally, these estimation outcomes also suggest that there exists no deleterious effect that goes beyond the purely budgetary impact, supporting the interpretation that no Leviathan-like behavior of the administrator is present that is not already reflected by the budgetary, endogenous variables. This finding contradicts the U.S. results in which a performance lowering impact in the structural form of the model remained (Downes, Dye, & McGuire, 1998).

For mathematics, I find that, again, stronger popular rights appear to exert a deleterious impact on student performance with the sub-federal school budget working as transmission channel. In contrast to the regressions for reading, however, a higher degree of direct

democracy leads to better student performance in the structural model – that is there is a direct achievement improving impact that becomes only evident when its indirect influence through the endogenous variables is accounted for. From this result it might be concluded that in more direct democratic cantons more resources are devoted to the teaching and learning of mathematics, potentially in form of additional school resources, which might have been withdrawn from other (non-test) school subjects. Such reallocation towards mathematics could be economically justified by higher expected returns on Beckerian human capital accumulation compared to those in reading and thereby reflect the policy-makers response to according demands in the population.

For natural science, neither a direct nor an indirect impact of direct legislation is detected. In explanation, it might well be that the late introduction of natural science subjects to the school curriculum does not allow political institutions to leave a decisive mark on ninth graders' test performances.

For all three subjects, qualification of teachers appears to be the most important determinant of student performance. The analyses show that a higher share of teachers with a university education significantly increases student test scores in all three subjects. Furthermore, a direct link between the extent of direct democracy, the level of educational spending per pupil, and teacher qualification could be established for all three core subjects. This result suggests that school budgets, in particular teacher qualification, work as a transmission channels of the institutional impact. Clearly, teacher quality matters a great deal for student performance, but it is questionable whether differences in teacher qualification do account for variation in quality. Previous studies have been inconclusive with respect to the influence of teacher qualification (see Hanushek, 2002), and it might well be that the results presented here are driven by the specific institutional setting in Switzerland. In other words, the relevance of teacher qualification for education might well be country-specific. Further research is needed before a generalized judgment can be made.

From these results for Switzerland, concluding that restricting people's direct control over the school budget leads to better student performance would be too simple. In fact, a spending restraint impact of direct legislation is only present in case voters are fiscally conservative. However, institutions of direct legislation equally allow to increase spending or to prevent cuts initiated by the government, as recent popular votes in Switzerland have revealed. In other words, what is needed is a debate in society about the objectives of public education and the amount of financial resources necessary to achieve them. Such discussion should take place not only in countries with institutions of direct democracy, but in any society. Based on this piece of research, the only policy-related concrete advice that can be given for Switzerland is to increase the share of teachers with a university education in schools, and organize public education in such way (including qualification requirements, career prospectus, wage structure) so that high quality teacher candidates are attracted. In this light, the recently started debate about attractiveness of teaching profession, optimal recruitment strategies as well as the call for university-level teacher education constitute initial steps in the right direction.

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Endnotes

1. The average test score of 494 for Switzerland was below the international mean of 500 for the PISA study.

2. Appropriate information on this issue can be found at www.educa.ch, or the Federal Statistical Office, www.bfs.admin.ch.

3. In contrast to these organizational differences across cantons, school curricula in primary and secondary I stages of education have been harmonized to a great extent.

4. See Romer & Rosenthal (1978, 1979, 1982, 1983) and Romer, Rosenthal, & Munley (1992).

5. Efficiency gains serve as explanation for the growth-improving impact of direct democracy detected by Feld & Savioz (1997).

6. The source ACIR (1995) provides a catalogue of existing tax limits. In contrast, Poterba (1997) does not report any significant influence of property tax limits on per pupil K-12 school spending by US states. Besides missing some political determinants in his model, it might well be that analysis at the aggregate level prevented identification of a significant impact.

7. Available at http://www.admin.ch/ch/d/sr/c101.html (10. Nov 2006)

8. For Switzerland, also Grob & Wolter (2005) analyze determinants of educational spending across cantons, but with a focus on socio-demographic characteristics solely. In their analysis, political institutions are missing.

9. Freitag & Bühlmann (2003) employ the number of held fiscal referenda and initiatives (in place of using the mere presence of institutions) with spending at the cantonal level as regressor, thus neglecting the financial contribution of local jurisdictions. Similarly, the data used by Santerre (1989) and Megdal (1983) are only cross-sectional and obtained from local jurisdictions, among which fierce competition might prevent any differential impact of political institutions. Moreover, Sass (1991), using the identical dataset as Santerre (1989), detects no institutional impact once endogeneity of government structure is accounted for.

10. Dye & McGuire (1997) identify a mitigating effect of strong competition between jurisdictions.

11. It is, however, questionable whether a change in the ratio of administration to production costs provides sufficient evidence for one of the two theories. If instruction costs are more variable than administrative costs, in the short term only a cut in instruction costs might be practical.

12. Earlier contributions to this topic from the 1970s until the very early 1990s, some empirical but most informal, are described in Downes & Figlio (1999). These contributions, however, suffer from methodological shortcomings.

13. In this study, although mitigated by competition among schools, a small negative impact of tax limits on student performance in mathematics is detected.

14. Some of them, however, employ educational spending at the district level as a controlling factor in addition to the policy measure and institutional dummies (e.g. Downes & Figlio 1997).

15. Combined cantonal and communal spending must be employed because in every single canton the financing of schooling is shared differently between these two tiers.

16. The PISA data are used in analyses of e.g. Fuchs & Woessmann (2004), Fertig & Wright (2005).

17. The peer group variables should be included to the model because an indirect institutional influence might be mediated through them. In this paper, however, we are interested in the direct institutional influence on a single student.

18. In small classes, there might even exist a feedback relation and continuing interaction between the one and the other(s) (for empirical literature on peer effects, see Zimmer & Toma, 2000; Summers & Wolfe, 1977; Epple, Romano, & Sieg, 2003; Rangvid, 2004).

19. The endogenous input factors in this study are district-level student-teacher ratios, student-administrator ratios, mean teaching experience of teachers, and share of teachers with B.A. or B.S. degree.

20. This estimation method is also applied by educational economists to the analysis of PISA results using an international sample containing several countries.

21. The full estimation results for the educational production function can be found in Table A5 of the Appendix.

22. These results are robust to assuming endogeneity or exogeneity of the government ideology and fiscal decentralization variables. Endogeneity of fiscal decentralization might be caused by the correlation between the educational spending and total government spending variables, albeit probably to a small degree. Government ideology might be endogenous in case higher educational spending induces formerly disenfranchised and economically marginalized groups favoring income redistribution go to the polls. For similar results with government ideology treated as endogenous, see Fischer (2005).

23. This finding loosely corresponds with a result reported by Fuchs & Woessmann (2004) in an international PISA analysis.

24. Omission of peer effects leads to even stronger results for mathematics test scores.

25. Only for natural science a ten percent significance of the direct democracy variable occurred in half of the regressions in the structural model, then showing the identical pattern of influence as for the mathematics test results and supporting hypothesis 3.

26. Hanushek, Kain, & Rivkin (2004) report that teachers in the US who switch schools choose institutions with better performing, higher income student bodies with a lower share of minority members.

27. Selectivity is assumed in case admission is granted based on previous performance or by passing an entrance examination.

28. The figures are based on samples with outliers excluded by 1.5 standard deviations of the residuals. The continuous line represents the regression line of the bivariate analysis.

29. Indeed, teacher salary is among the factors which makes schools attractive to teachers (Hanushek, Kain & Rivkin, 2004; Figlio, 1997a).

30. For this reason, the model does not include fiscal, political or economic determinants of educational spending. The remaining controlling determinants include the degree of urbanization, the share of residents with a higher education, the size of the canton in terms of population, the share of old residents and of those in school age, the share of foreigners, the share of impoverished persons, a cultural variable, and a dichotomous variable for being a town-sized canton, that often cannot afford and does not to offer secondary II education preparing for university admission. I also control for school type and location. Estimation technique is OLS with clustering by cantons. Whenever possible, all variables have been averaged over 1990 to 2000.

31. The results for the complete samples can be found in Table A6 of the Appendix. Exclusion of outliers yields a considerable increase in goodness of fit from about 0.2 (Table A6) up to 0.57 (Table 4).

32. Estimation of the model with direct democracy included alongside with the spending variable shows that the school budget partly mediates the institutional impact teacher qualification in reading, mathematics and natural science.

33. For more literature on the impact of financial resources in general available to schools on education, see e.g. Hanushek (1996, 1997, 2002), Ludwig & Bassi (1998), Card & Payne (2002).

34. Depending on the canton, physics and chemistry are introduced either in the 7^{th} or 8^{th} grade.

35. For literature on the influence of teachers' wages on student outcomes, see Hanushek, Kain, & Rivkin (1999, 2004), Figlio (1999); and finally, for quality of teaching see e.g. Hanushek (2003), Buckingham (2003).

36. Estimating a more flexible Box-Cox transformation model, Meunier (2004) reports performance enhancing influence of the share of teaching personnel with a university degree on student performance for all three core subjects.

37. In 2002, the Swiss government and the cantons decided to reform the system of teacher education. From 2004 on, only persons with a completed secondary II education shall be admitted to teacher training and educated either at universities or at newly founded colleges of education (EDK, 2001).

38. This is the case for e.g. most US states and Germany.

[39] Fischer (2005) shows that instructional spending is reduced to a lesser extent than administrative spending, clearly rejecting the Leviathan-hypothesis. Unfortunately, Swiss data on educational expenses are not available at the school district level. Furthermore, cantonal data provided by the Swiss Federal Statistical Office do not allow to split the budget into more disaggregated components similar to those used in the US studies.

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Tables

Table 1: Descriptive statistics for test scores

Variable	Obs.	Mean	Std. Dev.	Min	Max
Total sample					
reading	7979	498.297	92.532	27.60	884.49
mathematics	4440	529.563	94.063	202.14	815.90
natural science	4443	497.601	95.638	168.60	830.09
Reduced form sample					
reading	3530	531.639	78.871	98.22	812.88
mathematics	1917	559.255	80.658	202.14	815.9
natural science	1593	525.963	91.515	168.6	804.54
Structural form sample					
reading	3071	532.738	78.681	166.01	812.88
mathematics	1655	559.362	81.211	202.14	815.9
natural science	1262	530.829	91.267	168.6	804.54

Table 2: Determinants of educational spending for compulsory schooling in Swiss cantons, 1980 – 1998

	(1) Total	(2) Outliers excluded
Direct Democracy	-0.264**	-0.211**
	(6.55)	(5.20)
Fiscal decentralization	0.383(*)	0.14
	(1.81)	(0.90)
Tax competition	-1.007*	-1.462**
	(2.27)	(4.49)
Lumpsum transfers	-0.296**	-0.552**
	(2.80)	(6.88)
Fiscal constraints	0.004	0.005
	(0.17)	(0.23)
Coalition size	0.137**	0.087*
	(2.84)	(2.41)
Ideology of government	-0.064	-0.354**
	(0.35)	(2.61)
French- or Italian-speaking canton	-0.816**	-0.690**
	(4.93)	(4.47)
Urbanization	-0.002	-0.003
	(1.00)	(1.54)
National income	-1.070**	-0.725**
	(4.03)	(3.22)
Small canton	-0.357**	-0.428**
	(4.67)	(7.26)
Share of highly educated	0.030**	0.026**
	(2.67)	(2.81)
Share of old people	-0.084**	-0.061**
	(4.36)	(4.07)
Share of young people	-0.083**	-0.048*
	(3.01)	(2.18)
Constant	19.704**	18.687**
	(13.32)	(15.02)
Observations	312	272
Adj. R2	0.720	0.811
Jarcque Bera test	5.539 (*)	5.311(*)

Note: OLS regression with standard errors calculated according to the Newey-West method. Time dummies are included but not reported. **, *, (*) denote significances at the 1, 5 and 10 percent levels, respectively.

Table 3: OLS Regressions for PISA test scores

	(1)	(2)	(3)	(4)	(5)	(6)
	reading		mathematics		natural science	
Direct Democracy	-9.377*	-1.546	0.190	10.462*	-2.937	7.183
	(2.45)	(0.34)	(0.04)	(2.25)	(0.61)	(1.61)
French- or Italian-speaking region	-5.294	3.183	19.21	34.748*	32.400*	7.836
	(0.46)	(0.26)	(1.40)	(2.41)	(2.34)	(0.60)
Individual-level variables	included		included		included	
Type and location of school	included		included		included	
Class-level determinants	included		included		included	
Peer-group variables	included		included		included	
Cantonal-level determinants	included		included		included	
Poor conditions 1 at school		0.966		4.525		5.647
		(0.11)		(0.34)		(0.43)
Poor conditions 2 at school		-4.791		-4.923		-56.732**
		(0.41)		(0.40)		(3.02)
No access to PC at school		-6.543*		-6.450		4.418
		(2.15)		(1.40)		(0.73)
Teacher shortage in test subject		-2.841		5.120		-29.717*
		(0.26)		(0.42)		(2.49)
Share of test subject teachers with a master's degree		25.473*		28.838**		22.983*
		(2.55)		(2.82)		(2.29)
Share of teaching personnel with a master's degree		22.819*		19.539		35.682**
		(1.99)		(1.49)		(2.70)
Total hours of schooling (all subjects)		0.024		0.076*		0.111*
		(0.77)		(2.09)		(2.60)
Student-teacher ratio		-0.103		0.311		1.299(*)
		(0.17)		(0.51)		(1.86)
Constant	607.681**	486.375**	556.930**	347.356*	629.763**	584.424**
	(5.62)	(3.66)	(3.57)	(2.23)	(4.69)	(4.06)
Observations	3530	3071	1917	1655	1593	1262
F-test	28.31**	27.70**	13.36**	13.73**	13.73**	22.49**
Number of schools	192	164	179	153	180	134
Adjusted R2	0.27	0.28	0.21	0.23	0.29	0.32

Note: OLS regressions with robust standard errors obtained through clustering by schools. **, *, (*) denote significances at the 1, 5 and 10 percent levels, respectively.

Table 4: Educational spending and qualification of teachers

	reading	all subjects	mathematics	natural science
log (educational spending)				
1990 – 2000	1.664*	2.892**	2.484**	1.245(*)
	(2.40)	(5.29)	(3.01)	(1.91)
French- or Italian-speaking				
canton	0.499**	0.099	0.420**	0.570**
	(5.31)	(1.70)	(4.04)	(5.90)
School variables	included	included	included	included
Cantonal determinants	included	included	included	included
Number of schools	167	171	174	155
Adj. R2	0.570	0.574	0.434	0.543
Jarcque Bera test	5.701(*)	4.423	5.733(*)	1.751

Note: OLS regression with robust standard errors obtained through clustering by cantons. **, *, (*) denote significances at the 1, 5 and 10 percent levels, respectively. Dependent variable is the percentage of teachers of the subject with a master's degree. Controlling variables at the cantonal level include the degree of urbanization, the share of residents with a higher education, the size of the canton in terms of population, the share of old residents and of those in school age, the share of foreigners, the share of impoverished persons, and a dichotomous variable for town-sized cantons. School-level determinants account for type of school (private/state), selectivity, and location of school (village, town, small city, large city). Outliers have been excluded based on 1.5 s standard deviation of the residual.

Figures

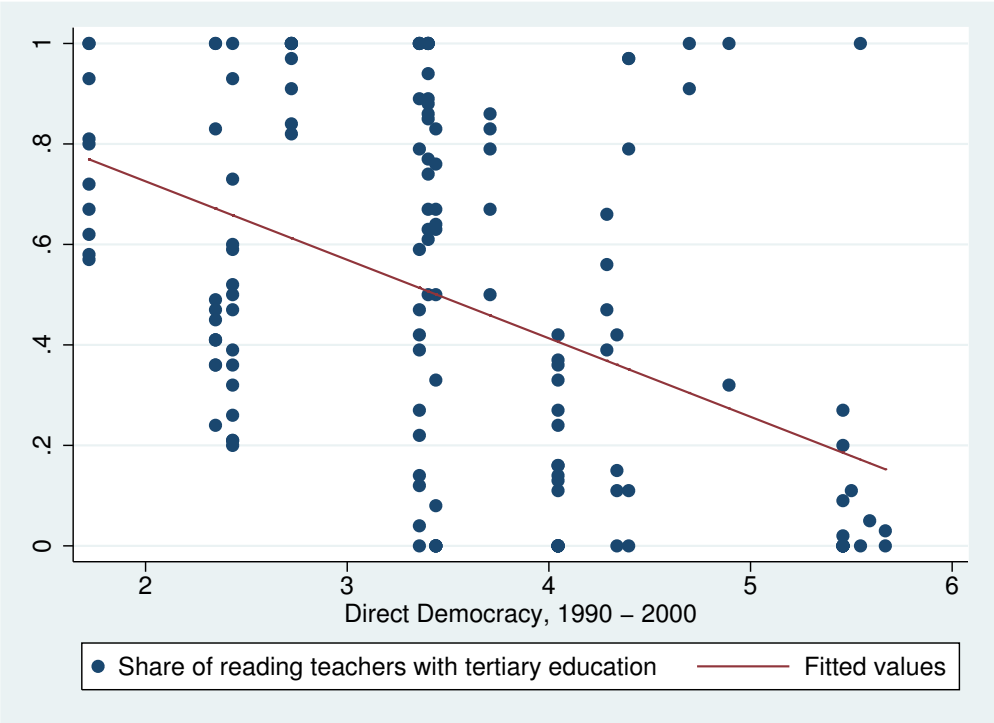

Figure 1. Direct democracy and teacher qualification I

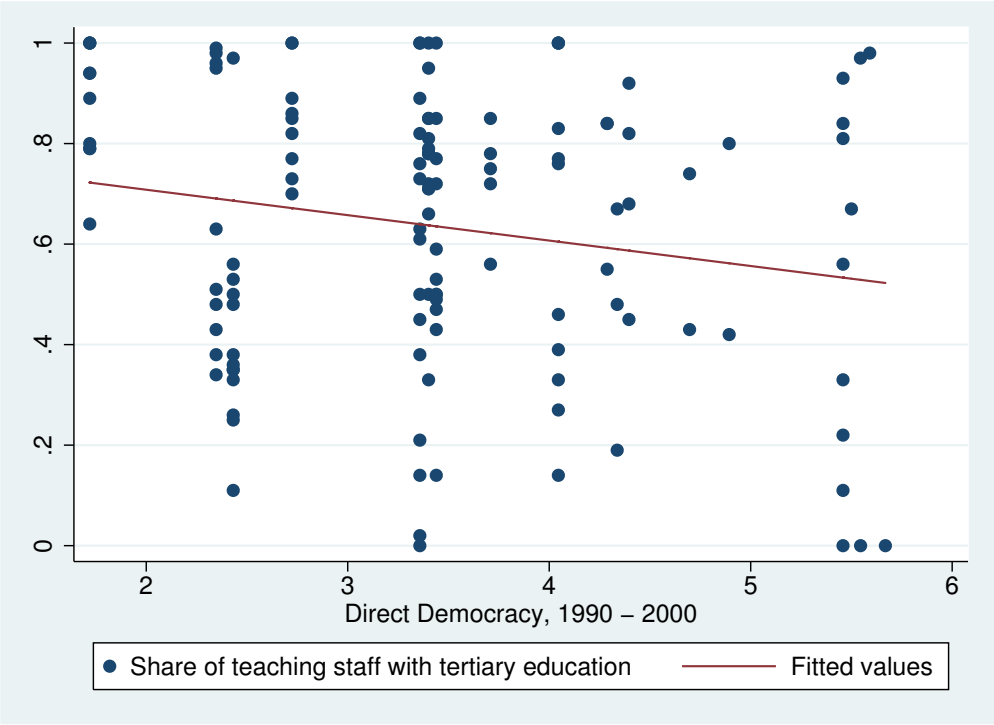

Figure 2. Direct democracy and teacher qualification II

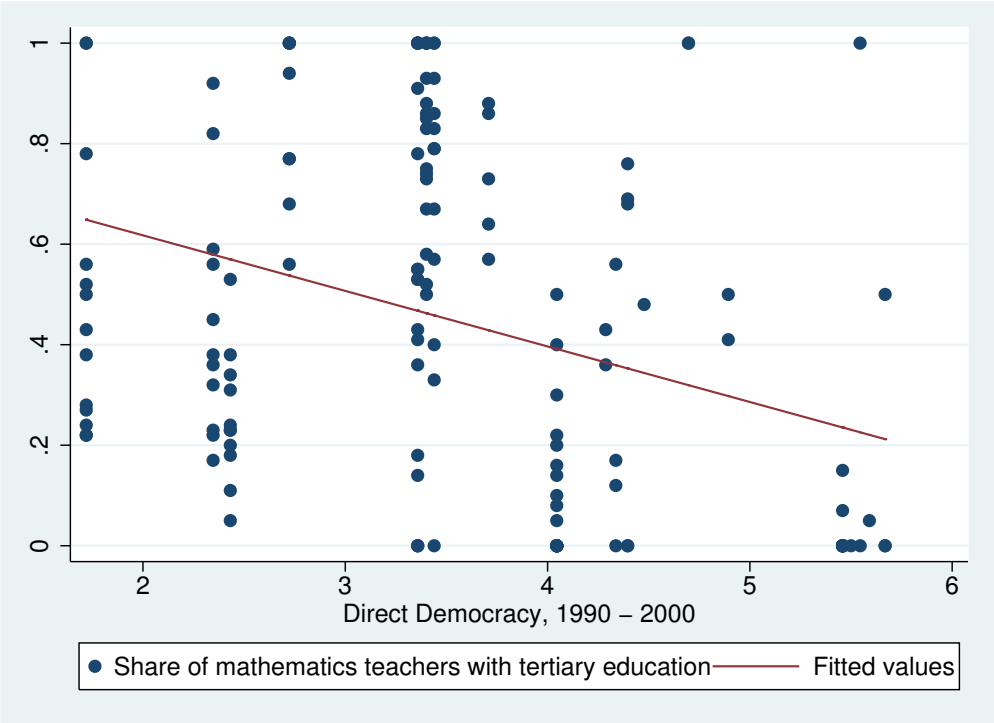

Figure 3. Direct democracy and teacher qualification III

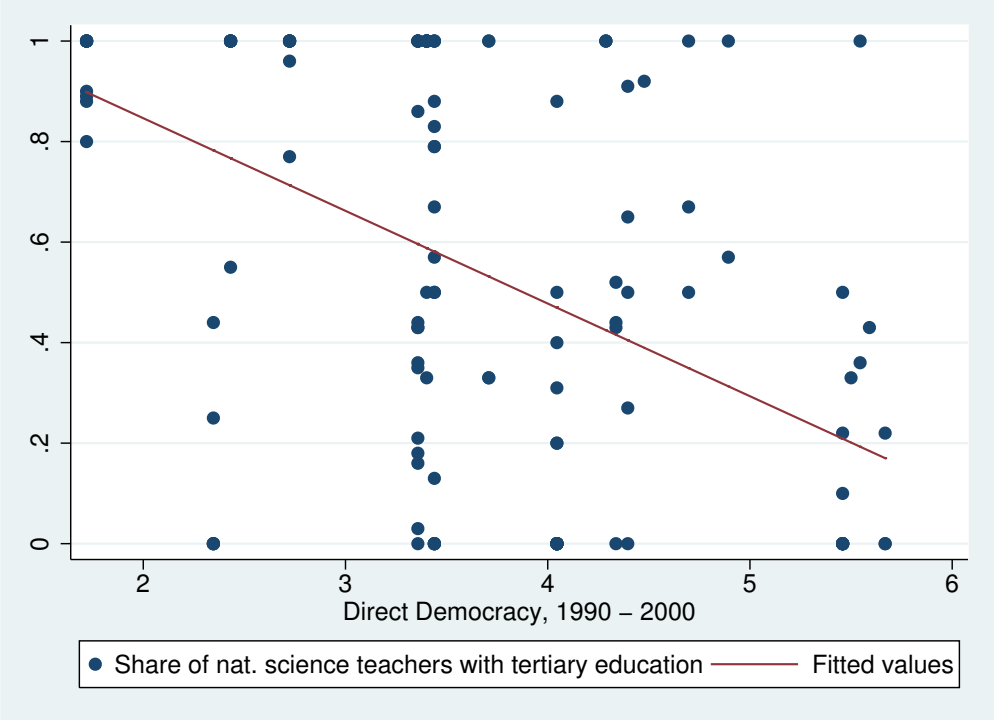

Figure 4. Direct democracy and teacher qualification IV

Appendix

Table A1: Distribution of observations for reading and the extent of direct democracy in Swiss cantons

	Reduced form	Structural form	Direct Democracy in 2000
Zürich	200	169	3.500
Bern	373	339	3.021
Luzern	67	56	4.417
Uri	-	-	5.125
Schwyz	26	26	4.927
Obwalden	21	21	4.625
Nidwalden	-	-	4.438
Glarus	8	8	5.750
Zug	11	11	4.417
Freiburg	572	515	2.792
Solothurn	20	20	5.250
Basel-Stadt	46	45	4.396
Basel-Landschaft	55	30	5.479
Schaffhausen	-	-	5.208
Appenzell-Ausserrhoden	1	1	5.500
Appenzell-Innerrhoden	-	-	5.438
St. Gallen	378	247	3.458
Graubünden	23	23	4.833
Aargau	215	171	5.458
Thurgau	66	54	4.333
Tessin	-	-	2.250
Waadt	226	210	2.500
Wallis	353	349	3.583
Neuenburg	370	370	2.188
Genf	322	229	1.750
Jura	177	177	3.708
German-speaking cantons	1534	1245	
French-speaking cantons	1996	1826	
Sum	3530	3071	

Swiss cantons appear in so-called historical sequence and in German denomination.

Table A2: Description of variables

Variables	Description
Dependent variable	WARM estimate (weighted likelihood estimate): difficulty adjusted test score in reading literacy / mathematics / natural science test
Direct democracy	Index of direct democracy from 1 (min.) to 6 (max.) in 2000
French- or Italian-speaking region	1 if language community is either French- or Italian-speaking, 0 otherwise (cantreg)
Individual and family variables	
Occupational status 2	PISA International Socio-Economic Index of Occupational Status of the parents as a proxy of income, 28 – 37 index points
Occupational status 3	38 – 47 index points
Occupational status 4	48 – 57 index points
Occupational status 5	58 – 67 index points
Occupational status 6	68 – 77 index points
Occupational status 7	>78 index points
No occupational status data	1 if missing value in hisei-Index (hisei), 0 otherwise
Number of siblings	Number of siblings (nsib)
Old student	1 if student older than 204 months / 15 years (age), 0 otherwise
Young student	1 if student younger than 180 months / 17 years (age), 0 otherwise
Books at home	Number of books at home (st37q01)
No late arrival at school	1 if student claims never to have arrived late for school in the last two school weeks (st29q03), 0 otherwise
No PC at home	1 if student never has access to a PC at home (it01q01), 0 otherwise
Female student	1 if student is female, 0 otherwise (st03q01)
Both parents work	1 if both parents work, either full time or part time (st07q01, st06q01), 0 otherwise
Intact family	1 if student usually lives with father and mother (st04q01, st04q03), 0 otherwise
Native student	1 if country of birth is Switzerland (st16q01), 0 otherwise
Foreign parents	1 if country of birth of both father and mother is not Switzerland (st16q02, st16q03), 0 otherwise
Second generation	1 if only one parent is born abroad (st16q02, st16q03), 0 otherwise
No test language spoken at home	1 if language spoken at home is not test-language (st17q01), 0 otherwise
Parents medium education	Father and/or mother completed lower secondary level (fisced, misced)
Parents high education	Father and/or mother completed upper secondary level (fisced, misced)
Mother tertiary education	Mother completed tertiary education (misced)
Father tertiary education	Father completed tertiary education (fisced)
Family culture: Discussion of politics	1 if student regularly discusses political or social issues with parents (st19q01), 0 otherwise
Family culture: Listening to classical music	1 if student regularly listens to classical music together with parents (st19q03), 0 otherwise
Family culture: Main meal eaten together	1 if several times a week parents eat main meal with student (st19q05), 0 otherwise
Family culture: Regular talking	1 if several times a week parents spend time just talking to the student (st19q06), 0 otherwise

Table A2: Description of variables (cont.)

School and class variables	
Village school	1 if school is located in a village (< 3000 E) (sc01q01), 0 otherwise
Small town school	1 if school is located in a small town (3000 – 15 000) (sc01q01), 0 otherwise
City school	1 if school is located in a city (100 000 to 1 000000) (sc01q01), 0 otherwise
Private school	1 if school is private, 0 otherwise (sc03q01)
Selective school	1 if admission to school is always based on student's record of academic performance including placement tests, 0 otherwise
Regular testing in class	1 if students are assessed four or more times a year using standardized or teacher developed tests, 0 otherwise (sc16q01, sc16q02)
Homework feedback	1 if homework is counted as part of mark or teachers grade homework most of the time or always (st32q07, st32q03), 0 otherwise
Problems with discipline in class	1 if in most lessons or in every lesson, students don't listen to what the teacher says, students don't start working for a long time after the lesson begins, there is noise and disorder, or at the start of class more than five minutes are spent doing nothing (st26q13, st16q14, st26q16, st26q17)
Peer variables	
Peer performance in test subject	Peers' mean performance divided by peers' standard deviation in test subject test scores
Share of female peers	Share of female students in student's peer group
Share of foreign peers	Share of students born abroad in student's peer group
Cantonal variables	
Cantonal share of well educated people	Share of cantonal residents with a tertiary education or a high school degree
Share of aged residents	Share of cantonal residents older than 65 years
Unemployment rate	Cantonal unemployment rate
Share of Protestants	Share of Protestant residents in canton
Share of Muslims	Share of Muslim residents in canton
Share of persons with no religious denomination	Share of residents with no religious affiliation
Share of poor persons	Share of persons who cannot afford savings of 100 CHF per month (SHP data)
Urbanization	Share of residents living in agglomerations with at least 100,000 inhabitants
Size of canton	Natural logarithm of the cantonal residential population
Revenue-driven inputs	
Poor conditions at school 1	1 if school suffers from poor building, poor heating and/or inadequate space (sc11q01 sc11q02 sc11q03), 0 otherwise
Poor conditions at school 2	1 if school suffers from a lack of instructional material and /or a poor library (a lot) (sc11q04 sc11q06), 0 otherwise
No access to PC at school	1 if student has no access to PC at school (it01q02), 0 otherwise
Teacher shortage in test subject	1 if a shortage of teachers in general and /or test subject teachers in particular (Some/a lot) (sc21q01, sc21q02), 0 otherwise
Share of test subject teachers with a master's degree	Proportion of language /mathematics /natural science teachers with a master's degree at school (propread /propmath /propscie)

Table A2: Description of variables (cont.)

Share of teaching personnel with a master's degree	Proportion of teachers with a master's degree of teaching personnel at school (propqual)
Total hours of schooling	Total number of schooling hours per year (tothrs)
Student-teacher ratio	Student-teacher ratio as school size divided by number of teachers (stratio)

Notes: In parentheses are the names of the variables on which the determinants of student performance are based. These labels are identical to those used in the OECD-PISA study conducted by the OECD in 2000. The questionnaires used for the Swiss national study are also identical to those used for the PISA study with the exception of a few questions which are irrelevant to this model specification. These labels also provide information about which questionnaire contained the original question. The first two letters either indicate 'st' for student questionnaire, 'it' for the information technology questionnaire, or 'sc' for the school questionnaire. The first two digits then stand for the number of the general issue, and 'qXX' for the related single question. The following variables have already been derived and computed by the issuing institution: *wleread*, *hisei*, *nsib*, *miscedu*, *fiscedu*, *stratio*, *tothrs* and are already part of the dataset. More information on the construction of these variables can be obtained from the issuing institution at http://www.sidos.ch/data/projects/pisa/ (13.04.2004). Base categories are schools in small towns (15,000 to 100,000 inhabitants), a low parental income (*hisei1*: below 28 index points), and a high but not tertiary education of parents (*misced* = 4 or 5, *fisced* = 4 or 5).

Sources: all individual-level, school-level and peer-level variables are obtained from the National PISA study or derived from it. The index of direct democracy is based on based on Stutzer (1999) and on own calculations. All cantonal-level variables are obtained from the Swiss Federal Statistical Office except for the share of poor people, which is derived from the 2000 wave of the Swiss Household Panel.

Table A3: Descriptive statistics of regressors and regressands

	Obs.	Mean	Std. Dev.	Min	Max
Reading test score	3071	532.74	78.68	166.01	812.88
Direct democracy	3071	3.21	0.95	1.75	5.75
French- or Italian-speaking region	3071	0.59	0.49	0	1
Occupational status 2	3071	0.11	0.31	0	1
Occupational status 3	3071	0.23	0.42	0	1
Occupational status 4	3071	0.24	0.43	0	1
Occupational status 5	3071	0.05	0.23	0	1
Occupational status 6	3071	0.21	0.40	0	1
Occupational status 7	3071	0.05	0.21	0	1
No occupational status data	3071	0.08	0.27	0	1
Number of siblings	3071	2.55	3.72	0	24
Old student	3071	0.03	0.16	0	1
Young student	3071	0.23	0.42	0	1
Books at home	3071	4.75	1.51	1	7
No late arrival at school	3071	0.72	0.45	0	1
No PC at home	3071	0.08	0.27	0	1
Female student	3071	0.52	0.50	0	1
Both parents work	3071	0.64	0.48	0	1
Intact family	3071	0.86	0.35	0	1
Native student	3071	0.90	0.30	0	1
Foreign parents	3071	0.15	0.36	0	1
Second generation	3071	0.15	0.36	0	1
No test language spoken at home	3071	0.13	0.34	0	1
Parents medium education	3071	0.34	0.47	0	1
Parents high education	3071	0.59	0.49	0	1
Mother tertiary education	3071	0.20	0.40	0	1
Father tertiary education	3071	0.35	0.48	0	1
Family culture: Discussion of politics	3071	0.14	0.34	0	1
Family culture: Listening to classical music	3071	0.04	0.19	0	1
Family culture: Main meal eaten together	3071	0.93	0.26	0	1
Family culture: Regular talking	3071	0.59	0.49	0	1
Village school	3071	0.08	0.28	0	1
Small town school	3071	0.51	0.50	0	1
City school	3071	0.11	0.32	0	1
Private school	3071	0.06	0.23	0	1
Selective school	3071	0.60	0.49	0	1
Regular testing in class	3071	0.84	0.36	0	1
Homework feedback	3071	0.28	0.45	0	1
Problems with discipline in class	3071	0.55	0.50	0	1
Peer performance in reading	3071	7.30	1.77	3.48	12.85
Share of female peers	3071	50.58	9.13	0	100
Share of foreign peers	3071	13.09	8.15	0	48.28
Cantonal share of well educated people	3071	24.27	4.65	15.49	35.63
Share of aged residents	3071	15.08	1.67	11.88	20.97
Unemployment rate	3071	2.10	0.81	0.5	4.4
Share of Protestants	3071	29.41	18.10	6.31	67.10
Share of Muslims	3071	3.64	1.21	1.87	6.72
Share of persons with no religious denomination	3071	10.84	6.84	3.74	31.02
Share of poor persons	3071	17.07	6.85	1.73	35.63
Urbanization	3071	58.80	21.30	14.80	100
Size of canton	3071	12.70	0.75	10.39	14.01

Table A3: Descriptive statistics of regressors and regressands (cont.)

	Obs.	Mean	Std. Dev.	Min	Max
Poor conditions at school 1	3071	0.05	0.22	0	1
Poor conditions at school 2	3071	0.04	0.20	0	1
No access to PC at school	3071	0.23	0.42	0	1
Teacher shortage in reading	3071	0.09	0.29	0	1
Share of reading teachers with a master's degree	3071	0.63	0.35	0	1
Share of teaching personnel with a master's degree	3071	0.68	0.27	0	1
Total hours of schooling	3071	976.15	85.83	579	1267
Student-teacher ratio	3071	12.85	3.63	1.89	49.3
Mathematics test score	1655	559.36	81.21	202.14	815.9
Peer performance in mathematics	1655	7.43	1.87	3.20	24.37
Teacher shortage in mathematics	1655	0.11	0.31	0	1
Share of mathematics teachers with a master's degree	1655	0.56	0.36	0	1
Natural science test score	1262	530.82	91.27	168.6	804.54
Peer performance in natural science	1262	6.94	1.89	3.37	20.12
Teacher shortage in natural science	1262	0.08	0.28	0	1
Share of natural science teachers with a master's degree	1262	0.64	0.41	0	1

Descriptive statistics are based on the sample or the structural models.

Table A4: Determinants of educational spending for compulsory schooling in Swiss cantons, current and investment expenditures, 1980 – 1998

	(1) Current expenses	(2) Outliers excluded	(3) Investment expenses	(4) Outliers excluded
Direct Democracy	-0.267**	-0.232**	-0.389**	-0.360**
	(6.61)	(5.89)	(6.44)	(7.29)
Fiscal decentralization	0.394(*)	0.124	0.784**	0.814**
	(1.85)	(0.76)	(2.62)	(2.75)
Tax competition	-1.089*	-1.572**	0.002	-0.691
	(2.44)	(4.78)	(0.00)	(1.30)
Lumpsum transfers	-0.300**	-0.573**	-0.530**	-0.749**
	(2.81)	(7.01)	(3.14)	(5.59)
Fiscal constraints	0.006	-0.005	0.027	0.026
	(0.24)	(0.23)	(0.74)	(0.87)
Coalition size	0.131**	0.106**	0.257**	0.321**
	(2.72)	(2.77)	(3.76)	(6.01)
Ideology of government	-0.071	-0.328*	0.205	-0.235
	(0.39)	(2.34)	(0.76)	(1.17)
French- or Italian-speaking canton	-0.851**	-0.785**	-1.078**	-1.301**
	(5.11)	(5.16)	(4.30)	(6.11)
Urbanization	-0.002	-0.002	-0.005	-0.007*
	(1.04)	(1.40)	(1.26)	(2.13)
National income	-1.066**	-0.751**	-1.945**	-2.123**
	(4.00)	(3.36)	(4.77)	(6.33)
Small canton	-0.350**	-0.425**	-0.951**	-0.872**
	(4.56)	(6.98)	(7.87)	(8.53)
Share of highly educated	0.031**	0.028**	0.043*	0.070**
	(2.71)	(3.04)	(2.20)	(4.70)
Share of old people	-0.087**	-0.059**	-0.183**	-0.154**
	(4.39)	(3.95)	(6.87)	(7.23)
Share of young people	-0.085**	-0.040(*)	-0.176**	-0.147**
	(3.05)	(1.77)	(4.76)	(4.80)
Constant	19.850**	18.712**	27.515**	27.501**
	(13.28)	(15.37)	(13.14)	(15.66)
Observations	312	269	312	277
Adj. R2	0.718	0.813	0.813	0.893
Jarcque Bera test	6.131*	1.962	4.855(*)	2.208

See Table 5.

Table A5: OLS regressions for PISA test scores

	(1)	(2)	(3)	(4)	(5)	(6)
	reading		mathematics		natural science	
Direct Democracy	-9.377*	-1.546	0.190	10.462*	-2.937	7.183
	(2.45)	(0.34)	(0.04)	(2.25)	(0.61)	(1.61)
French- or Italian-speaking region	-5.294	3.183	19.210	34.748*	32.400*	7.836
	(0.46)	(0.26)	(1.40)	(2.41)	(2.34)	(0.60)
Individual and family variables						
Occupational status 2	1.096	4.491	2.136	-0.708	-25.462(*)	-31.717*
	(0.13)	(0.51)	(0.20)	(0.06)	(1.94)	(2.29)
Occupational status 3	15.558*	14.122(*)	17.315(*)	10.35	-1.167	-13.317
	(2.10)	(1.77)	(1.71)	(0.95)	(0.09)	(0.97)
Occupational status 4	12.742(*)	12.01	5.238	-0.062	-6.949	-18.762
	(1.71)	(1.54)	(0.54)	(0.01)	(0.53)	(1.31)
Occupational status 5	27.247**	29.628**	12.712	9.221	15.863	5.754
	(2.80)	(2.88)	(1.17)	(0.80)	(1.06)	(0.36)
Occupational status 6	24.012**	24.453**	16.573	10.908	15.546	2.34
	(2.96)	(2.87)	(1.61)	(1.01)	(1.17)	(0.16)
Occupational status 7	32.412**	30.466**	30.907*	28.225*	30.476*	18.166
	(3.31)	(2.92)	(2.44)	(2.13)	(2.14)	(1.14)
No occupational status data	-2.806	-3.942	-3.020	-10.041	-25.989(*)	-27.804(*)
	(0.33)	(0.44)	(0.25)	(0.81)	(1.81)	(1.75)
Number of siblings	-0.917**	-0.956**	-0.315	-0.023	-1.093	-1.373(*)
	(3.09)	(3.00)	(0.71)	(0.05)	(1.58)	(1.87)
Old student	-30.109**	-29.348**	-29.809**	-27.675*	-24.384(*)	-28.455(*)
	(3.65)	(3.02)	(2.89)	(2.57)	(1.73)	(1.70)
Young student	10.450**	10.173**	6.404	6.528	11.037(*)	8.618
	(3.48)	(3.32)	(1.45)	(1.39)	(1.79)	(1.21)
Books at home	9.136**	8.612**	9.270**	8.890**	8.861**	7.346**
	(10.43)	(9.26)	(8.49)	(7.55)	(6.03)	(4.32)
No late arrival at school	2.712	2.957	4.992	6.22	17.518**	16.645**
	(0.92)	(0.95)	(1.28)	(1.41)	(3.36)	(2.87)
No PC at home	-16.187**	-14.146**	-21.243**	-17.179(*)	-19.435*	-27.020**
	(3.43)	(2.89)	(2.74)	(1.96)	(2.07)	(2.76)
Female student	18.256**	16.993**	-27.788**	-28.584**	-17.631**	-20.186**
	(8.00)	(7.19)	(8.59)	(8.29)	(4.56)	(4.74)
Both parents work	-0.396	-1.687	1.397	-1.382	-3.335	0.145
	(0.17)	(0.66)	(0.39)	(0.36)	(0.87)	(0.03)
Intact family	0.296	-0.526	3.449	6.306	8.438	10.881(*)
	(0.09)	(0.15)	(0.73)	(1.24)	(1.61)	(1.76)
Native student	4.349	3.05	0.242	3.342	22.037*	18.519
	(0.85)	(0.55)	(0.04)	(0.50)	(2.29)	(1.57)
foreign parents	-6.079	-5.346	-17.071*	-13.105(*)	-10.508	-13.179
	(1.33)	(1.06)	(2.43)	(1.74)	(0.97)	(0.94)
Second generation	1.516	2.612	-4.984	-4.294	6.899	3.623
	(0.47)	(0.72)	(1.03)	(0.85)	(1.15)	(0.55)
No test language spoken at home	-12.825**	-14.943**	-14.543*	-14.241(*)	-1.044	-5.582
	(3.00)	(3.22)	(2.08)	(1.82)	(0.12)	(0.54)
Medium education of parents	-3.745	-2.572	-12.583*	-12.649*	-2.539	-1.399
	(0.94)	(0.61)	(2.24)	(2.12)	(0.40)	(0.20)

Table A5: OLS regressions for PISA test scores (cont.)

	(1)	(2)	(3)	(4)	(5)	(6)
	reading		mathematics		natural science	
high education of parents	15.779**	15.270**	1.460	-0.416	22.804**	22.327**
	(3.94)	(3.65)	(0.26)	(0.07)	(3.90)	(3.41)
Tertiary education of mother	-2.573	-2.804	-8.191	-8.512	6.986	8.827
	(0.62)	(0.65)	(1.40)	(1.40)	(1.02)	(1.08)
Tertiary education of father	1.871	3.422	-0.791	-2.051	3.055	5.605
	(0.60)	(1.04)	(0.15)	(0.36)	(0.69)	(1.12)
Family culture:	7.562*	8.309*	3.062	4.755	2.127	2.757
Discussion of politics	(2.43)	(2.52)	(0.67)	(0.93)	(0.40)	(0.46)
Family culture:	-6.729	-5.452	-5.536	-6.017	14.458	23.674
Listening to classical music	(1.18)	(0.94)	(0.59)	(0.62)	(1.15)	(1.52)
Family culture:	4.618	4.893	6.648	7.649	-0.380	-3.108
Main meal eaten together	(0.90)	(0.90)	(1.03)	(1.05)	(0.05)	(0.37)
Family culture:	3.732	3.835	1.296	0.024	-3.511	-0.669
Regular talking	(1.35)	(1.31)	(0.35)	(0.01)	(0.87)	(0.16)
School and class variables						
Village school	-5.845	-3.563	-31.337**	-22.542*	-23.946*	-27.946*
	(0.59)	(0.34)	(2.85)	(2.44)	(2.14)	(2.23)
Small town school	-4.113	0.107	-9.969	-7.087	-5.068	-11.987(*)
	(0.76)	(0.02)	(1.47)	(1.11)	(0.68)	(1.70)
City school	14.68	7.659	7.884	5.158	15.572	8.244
	(1.64)	(0.72)	(0.62)	(0.35)	(1.12)	(0.56)
Private school	3.333	-0.214	-6.572	-4.604	3.118	13.994(*)
	(0.42)	(0.02)	(0.61)	(0.49)	(0.36)	(1.74)
Selective school	12.860**	4.667	9.066(*)	3.065	10.657(*)	-2.26
	(2.91)	(0.96)	(1.75)	(0.66)	(1.87)	(0.34)
Regular testing in class	7.302	8.46	5.493	0.000	10.32	2.014
	(1.26)	(1.46)	(1.00)	(0.00)	(1.22)	(0.23)
Homework feedback	-15.387**	-13.268**	-21.479**	-19.519**	-10.020*	-8.655
	(5.17)	(4.40)	(5.00)	(4.28)	(2.00)	(1.51)
Problems with discipline	-11.656**	-11.006**	-2.633	-5.163	-11.856**	-3.813
in class	(3.73)	(3.57)	(0.62)	(1.22)	(2.74)	(0.82)
Peer variables						
Peer performance in test subject	7.925**	6.148**	3.788*	4.402**	5.400**	0.663
	(4.73)	(3.34)	(2.46)	(3.36)	(2.84)	(0.30)
Share of female peers	0.08	-0.128	0.281	-0.047	-0.116	-0.762*
	(0.35)	(0.50)	(1.01)	(0.18)	(0.35)	(2.13)
Share of foreign peers	-0.745(*)	-0.744(*)	-1.149**	-1.317**	-1.405**	-1.244**
	(1.80)	(1.70)	(2.73)	(2.89)	(2.96)	(2.79)
Cantonal variables						
Cantonal share of well educated						
people	1.074	0.345	2.218	2.511	-0.390	-1.720
	(0.93)	(0.27)	(1.49)	(1.64)	(0.26)	(0.93)
Share of aged residents	1.581	-3.553	2.534	-3.274	-1.496	-8.942(*)
	(0.50)	(1.00)	(0.51)	(0.69)	(0.35)	(1.80)
Unemployment rate	9.094	2.766	9.248	1.929	-4.520	-3.685
	(1.06)	(0.29)	(0.93)	(0.20)	(0.42)	(0.30)
Share of Protestants	0.173	0.374	0.452	0.842*	0.366	0.895*
	(0.55)	(1.00)	(1.13)	(2.08)	(0.85)	(1.99)
Share of Muslim	1.764	0.168	2.948	-0.408	3.592	-2.781
	(0.60)	(0.05)	(0.79)	(0.10)	(0.96)	(0.66)

Table A5: OLS regressions for PISA test scores (cont.)

	(1)	(2)	(3)	(4)	(5)	(6)
	reading		mathematics		natural science	
Share of persons with no religious denomination	0.720	1.840	-0.440	0.716	0.577	2.594
	(0.55)	(1.22)	(0.25)	(0.39)	(0.35)	(1.37)
Share of poor persons	-2.548**	-1.084	-2.452*	-1.011	-2.256*	-0.458
	(3.08)	(1.03)	(2.10)	(0.84)	(2.09)	(0.32)
Urbanization	-0.758(*)	-0.542	-0.509	-0.138	-0.257	-0.184
	(1.74)	(1.08)	(0.76)	(0.23)	(0.54)	(0.38)
Size of canton	-14.311	-4.208	-10.515	-0.964	-11.356	-6.899
	(1.59)	(0.37)	(0.89)	(0.08)	(1.03)	(0.56)
Poor conditions 1 at school		0.966		4.525		5.647
		(0.11)		(0.34)		(0.43)
Poor conditions 2 at school		-4.791		-4.923		-56.732**
		(0.41)		(0.40)		(3.02)
No access to PC at school		-6.543*		-6.45		4.418
		(2.15)		(1.40)		(0.73)
Teacher shortage in test subject		-2.841		5.120		-29.717*
		(0.26)		(0.42)		(2.49)
Share of test subject teachers with a master's degree		25.473*		28.838**		22.983*
		(2.55)		(2.82)		(2.29)
Share of teaching personnel with a master's degree		22.819*		19.539		35.682**
		(1.99)		(1.49)		(2.70)
Total hours of schooling (all subjects)		0.024		0.076*		0.111*
		(0.77)		(2.09)		(2.60)
Student-teacher ratio		-0.103		0.311		1.299(*)
		(0.17)		(0.51)		(1.86)
Constant	607.681**	486.375**	556.930**	347.356*	629.763**	584.424**
	(5.62)	(3.66)	(3.57)	(2.23)	(4.69)	(4.06)
Observations	3530	3071	1917	1655	1593	1262
F-test	28.31**	27.70**	13.36**	13.73**	13.73**	22.49**
Number of schools	192	164	179	153	180	134
Adjusted R2	0.27	0.28	0.21	0.23	0.29	0.32

See Table 3.

Table A6: Educational spending and qualification of teachers

	reading	all subjects	mathematics	natural science
log (educational spending) 1990 – 2000	1.403	2.111(*)	1.826*	0.942
	(1.54)	(2.08)	(2.36)	(0.78)
French- or Italian-speaking canton	0.434**	0.085	0.322**	0.410*
	(4.62)	(0.87)	(3.47)	(2.40)
School variables	included	included	included	included
Cantonal determinants	included	included	included	included
Number of schools	197	201	198	178
Adj. R2	0.201	0.282	0.172	0.170
Jarcque Bera test	5.295(*)	3.131	4.883(*)	3.597

Note: see Table 4